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(54) Title of the Invention: Electronically controlled mechanical timepiece

(57) Abstract:
Object: To provide an electronically controlled mechanical timepiece that permits an increased rotating speed for a rotor when a power generator is being driven and that shortens the operating time of a rotation control means, thereby reducing errors during hand-setting operations.
Solution: An electronically controlled mechanical timepiece includes a rotation drive means 70 having a drive lever 71 that comes into contact with a 5th gear 10 of a gear train connected to a power generator that applies rotating force to the 5th gear 10. The drive lever 71 in contact with the 5th gear 10 is separated from the 5th gear 10 in conjunction with the operation of a crown 60, which creates frictional force that is used to apply mechanical rotating force to the 5th gear which causes a rotor to rotate. A higher rotating speed of the rotor can be obtained more rapidly, which makes it possible for the power generator to provide greater output in a short period of time, so that the time required to activate the rotation control means after the start up of the power generator can be shortened, thereby reducing errors during hand-setting operations.

What is claimed is:

1. An electronically controlled mechanical timepiece comprising:

a mainspring;

a power generator for converting into electric energy mechanical energy that is transmitted via a gear train;

hands connected to said gear train; and

a rotation control means, driven by said converted electric energy, for controlling the rotation cycle of said power generator;

wherein a rotation drive means is included, which drives the power generator by rotating a subject gear to be rotated that is disposed in the gear train connected to the power generator by means of rotating force mechanically applied to the subject gear to be rotated, in conjunction with a restoring operation performed to restore the timepiece from a hand setting operation during which the operation of the power generator has been suspended.

2. An electronically controlled mechanical timepiece according to Claim 1, wherein the subject gear to be rotated by said rotation drive means is a gear in the gear train positioned 2 or 3 steps before the rotor of the power generator.

3. An electronically controlled mechanical timepiece according to Claim 1 or 2, wherein said rotation drive means includes a lever that is pressed against the outer circumference of said subject gear to be rotated when a crown for said electronically controlled mechanical timepiece is pulled out, and is separated from said subject gear to be rotated in conjunction with an operation to push in the crown when the operation is completed, thereby applying mechanical force to the subject gear to be rotated.

4. An electronically controlled mechanical timepiece according to Claim 3, wherein said lever is arranged so as to move away from the subject gear to be rotated with a uniform force by means of spring force.

Detailed Description of the Invention

Field of the Invention

[0001] The present invention relates to an electronically controlled mechanical timepiece, in which mechanical energy developed at the time of a release operation of

a mainspring is converted into electric energy by a power generator and a rotation drive means is operated by the electric energy to control rotation cycles for the power generator, thereby driving hands accurately that are secured to a gear train.

Description of the Related Art

[0002] Japanese patent publication number Hei 8-5758 discloses an electronically controlled mechanical timepiece, wherein the timepiece accurately drives the hands that are secured to a gear train to display accurate time by converting mechanical energy developed at the time of a release operation of a mainspring into electric energy and by using the electric energy to operate a rotation control means to control the value of a current flowing through a coil of a power generator.

[0003] In the aforementioned electronically controlled mechanical timepiece the electric energy developed by the power generator is first supplied to a smoothing capacitor to drive a rotation control means by the electric power from the capacitor. Because the electromotive force of an alternating current synchronous with the rotation cycle of the power generator is inputted to the capacitor, however, it is not necessary to retain electric power for a long time in order to make possible the operation of a circuit control means comprising an IC or a quartz crystal. This is the reason why capacitors with relatively small capacitance, which are sufficient to drive an IC and a quartz crystal for several seconds, have been conventionally used.

[0004] The electronically controlled mechanical timepiece is characterized by the features that no motor is needed because the mainspring serves as the power source that drives the hands and a small number of components are necessary, which thereby results in reduced cost. Moreover, it is necessary to generate only a small amount of electric energy to operate the electronic circuit, and it is possible to operate the timepiece with a small input energy.

Problem to be Solved by the Invention

[0005] However, the electrically controlled mechanical timepiece has the following problem. That is, normally when the crown is pulled out to set the hands (i.e., during time setting) , the hour, minute and second hands all stand still in order to set the time accurately. If the hands stand still, however, the gear train also stands still, and the power generator stops operating.

[0006] Thus, the input of electromotive force from the power generator to the smoothing capacitor is suspended, while the IC continues to work. Therefore, the load stored in the capacitor is discharged to the IC side and the terminal voltage drops,

causing the circuit control means to stop operating.

[0007] Consequently, it takes time to charge the capacitor in order to increase its terminal voltage sufficiently to drive the IC after the crown has been pushed in to drive the power generator after completing a hand-setting operation. In particular, because the rotor of the power generator comprises an inertial disk, the rotor increases its rotating speed gradually when the power generator starts up. This requires larger torque at the time the rotor starts rotating, and it takes time for the rotating speed to increase. As a result, the amount of power outputted by the power generator is rather small when the power generator first starts up, and it takes time to charge the capacitor so that the terminal voltage reaches a high enough level to drive the IC. This creates a problem in that there is a delay in starting IC operation after the power generator starts up and this makes it difficult to set time accurately during that delay.

[0008] The object of the present invention is to provide an electronically controlled mechanical timepiece that makes it possible to increase the rotating speed of the rotor at the time the power generator starts up compared to the technique found in the prior art, thereby reducing the time required to operate the rotation control means from the start up of the power generator which reduces errors during hand-setting operations.

Means for Solving the Problem

[0009] An electronically controlled mechanical timepiece according to the present invention comprises a mainspring, a power generator for converting into electric energy mechanical energy developed by the mainspring and transmitted via a gear train, hands connected to the gear train, and a rotation control means driven by the converted electric energy for controlling the rotation cycle of the power generator, wherein a rotation drive means is included which drives the power generator by rotating a subject gear to be rotated that is disposed in the gear train connected to the power generator by means of rotating force mechanically applied to the subject gear be rotated, in conjunction with a restoring operation performed to restore the timepiece from a hand setting operation during which the operation of the power generator is suspended.

[0010] According to the present invention, when a restoring operation is performed to restore the timepiece back from a hand setting operation during which the operation of the power generator is suspended, a rotating force is mechanically applied by the rotation drive means to the subject gear to be rotated in the gear train in conjunction with the restoring operation. In this way, the mechanical force is applied to the rotor of the power generator by the rotation drive means via the gear train only when the

power generator starts up and it supplements the rotating force developed by the mainspring, which allows a larger rotating force to be applied momentarily to the rotor, thereby providing an increased rotating speed for the rotor when it starts its rotating operation.

[0011] Therefore, it is possible to obtain a high value of power outputted by the power generator in a short period of time, thereby reducing the length of time between the start up of the power generator and the operation of the rotation control means which consequently reduces errors in hand-setting operations.

[0012] It is preferable that the subject gear to be rotated by the rotation drive means be positioned in the gear train 2 or 3 steps before the rotor of the power generator.

[0013] The maximum rate by which the speed increases for each gear in the gear train is about 12. Therefore, if a gear positioned 1 step before the rotor is set to be the subject gear to be rotated, in order to allow a relatively large rotating angle for the rotor, the subject gear to be rotated also has to be able to make a big rotation, which makes the structure of the rotation drive means more complicated. On the other hand, the rate by which the speed increases for a gear positioned 4 steps or more before the rotor becomes much greater and this requires a very large force in order to rotate the gear. This also makes the structure of the rotation drive means more complicated and it is possible that the gear teeth will tend to wear away because of a large force applied to them.

[0014] In light of the above, positioning the subject gear to be rotated 2 or 3 steps before the rotor makes it possible to obtain a larger amount of rotation for the rotor relative to a rotation amount for the subject gear to be rotated and it also reduces the rotating force applied to the subject gear to be rotated to a relatively small amount.

[0015] Furthermore, the rotation drive means may include a lever that is pressed against the outer circumference of the subject gear to be rotated when the crown is pulled out and is separated from the subject gear to be rotated in conjunction with the operation to push in the crown in order to apply mechanical rotating force to the subject gear to be rotated.

[0016] Using a lever that works in conjunction with the operation to push in or pull out the crown as the rotation drive means improves ease of use. The lever is kept in contact with the outer circumference of the subject gear to be rotated, and because the mechanical rotating force is applied by means of the force created by releasing the lever, the lever operation can be simplified which in turn simplifies its structure.

[0017] It is preferable that the lever be arranged so that it is separated from the subject gear to be rotated by an invariable force by means of a spring force. Lever

operation by means of the spring force allows a uniform rotating force to always be applied to the subject gear to be rotated, resulting in uniform operation of power generator.

Description of the Preferred Embodiments

[0018] The preferred embodiments of the present invention are discussed hereunder referring to the accompanying drawings.

[0019] Fig. 1 is a top view showing the principal mechanism of an electronically controlled mechanical timepiece according to the first embodiment of the present invention, and Figs. 2 and 3 are cross sectional views of the mechanism shown in Fig. 1.

[0020] The electronically controlled mechanical timepiece comprises a mainspring 1a, a barrel wheel gear 1b, a barrel arbor 1c and a barrel cover 1d. The mainspring 1a has an outer end secured to the barrel wheel gear 1b and an inner end secured to the barrel arbor 1c. The barrel arbor 1c is held by a main plate 2 and a gear train bridge 3, and it is secured to a ratchet gear screw 5 so that the barrel arbor rotates together with a ratchet gear 4.

[0021] The ratchet gear 4 is engaged with a pawl 6 so that the ratchet gear 4 can rotate clockwise but not counterclockwise. The ratchet gear 4 rotates clockwise to wind up the mainspring 1a in the same manner as in an automatic or manual winding mechanism for mechanical timepieces, therefore omitting the need for further explanation herein.

[0022] The rotation of the barrel wheel gear 1b is increased 7 times and transmitted to the first gear 7, which in turn is increased 6.4 times and transmitted to the third gear 8, which in turn is increased 9.375 times and transmitted to the fourth gear 9, which in turn is increased 3 times and transmitted to the fifth gear 10, which in turn is increased 10 times and transmitted to the sixth gear 11, and which in turn is increased 10 times and transmitted to a rotor 12. As a result, the rotation speed increases a total of 126,600 times.

[0023] The 2nd gear 7 has a pinion 7a secured thereto, with the pinion 7a having a minute hand 13 secured thereto, and a second hand 14 is secured to the 4th gear 9. Thus, in order to rotate the 2nd gear 7 at 1 rph and the 4th gear 9 at 1 rpm, respectively, the rotor 12 may be controlled such that it rotates at 5 rpm. By doing so, the barrel wheel gear 1b rotates at 1/7 rph.

[0024] A power generator comprises the aforementioned rotor 12, a stator 15 and a

coil block 16. The rotor 12 comprises a rotor magnet 12a, a rotor pinion 21b and a rotor inertia disk 12c. The rotor inertia disk 12c is effective for reducing variations in the number of rotations of rotor 12 relative to variations in the drive torque associated with a barrel wheel 1. The stator 15 is made of 40,000 turns of a stator coil 15b wound around a stator body 15a.

[0025] A coil block is made of 110,000 turns of coil 16b wound around a magnet core 16a. In the present invention, the stator body 15a and the magnet core 16a are made of materials such as PC permalloy. The stator coil 15b and the coil 16b are connected in serial so that an output voltage is produced that adds the voltages generated in both of the coils.

[0026] Now, a control circuit for the electronically controlled mechanical timepiece will be discussed with reference to Fig. 4.

[0027] An alternating current output from a power generator 20 is boosted and rectified through a booster and rectifier circuit comprising a boosting capacitor 21 and diodes 22, 23 to charge a smoothing capacitor 30. The capacitor 30 has a rotation control means 50 connected thereto, and the rotation control means 50 comprises an IC 51 and a quartz crystal 52. The capacitor 30 is a laminated ceramic capacitor that has capacitance of about 1 μF. An electrolytic capacitor may be used as the capacitor 30, but a laminated ceramic capacitor is preferred because it has a longer life than an electrolytic capacitor and it may be expected to last for dozens of years.

[0028] When the capacitor 30 has accumulated a predetermined voltage that is high enough to drive the IC 51 and the quartz crystal 52, e.g., 1 volt, the IC 51 and the quartz crystal 52 are driven with the charged power and an elelctromagnetic brake amount is adjusted by allowing the amount of a current flowing in the coils of the power generator to vary, whereby the speed of the rotation cycle of the power generator, i.e., the speed of the rotation cycle of the hands can be adjusted.

[0029] As a means for allowing the amount of the current flowing in the coils to vary, there are effective methods, for example, in which a resistance in a load control circuit connected in parallel to both ends of the power generator is allowed to change as disclosed in embodiment 1 of Japanese Unexamined Patent Application Publication No. 8-101284 and in which the number of boosting stages is allowed to change as disclosed in embodiment 2 of the aforementioned patent application.

[0030] Such electronically controlled mechanical timepieces have a rotation drive means 70 that operates in conjunction with the operation of a crown 60, as shown in Figs. 5 - 7. The rotation drive means 70 comprises a drive lever 71 for rotating the 5th gear located in the middle of a gear train to drive the power generator, a click

lever 81 for moving the drive lever 71 and a click spring 91 for regulating the rotating positions of the click lever 81.

[0031] The click lever 81 is pivotally supported so as to rotate freely about a shaft 82 and is engaged with a shaft 61 of the crown 60. The click lever 81 comprises a positioning pin 83 that is engaged with a couple of engagement grooves 92, 93 formed in the click spring 91 and a contact pin 84 that comes into contact with the drive lever 71.

[0032] The drive lever 71 is made of metal or plastic which has elasticity and is pivotally supported so that it rotates about a shaft 72. The drive lever 71 has extended portions which are extended from the shaft 72 in three directions. One of the extended portions forms a lever stop portion 73 which comes into contact with a stopping pin 63 secured to the timepiece, which allows the drive lever 71 to be prevented from rotating clockwise from the position as shown in Fig. 5.

[0033] The drive lever 71 has another extended portion forming a lever contact portion 74 that is allowed to contact the outer circumference of the 5th gear 10.

[0034] Furthermore, the drive lever 71 has yet another extended portion forming a position control lever 75 that has a groove 76 in which the contact pin 84 of the aforementioned click lever 81 is disposed and a contact surface 77 with which the contact pin 84 makes contact, and the drive lever 71 also has a striking portion 78 that comes into contact with a crystal accommodating casing 53 for the quartz crystal 52.

[0035] The crystal accommodating casing 53 in which the quartz crystal 52 is placed is held by a main plate 2 and a circuit holder 66, as shown in Fig. 8.

[0036] Operation of the rotation drive means 70 according to the embodiment will now be discussed.

[0037] First, as shown in Fig. 5, when the crown is in a normal position where it is pushed in, the positioning pin 83 of the click lever 81 is engaged in the engagement groove 93 of the click spring 91, and the contact pin 84 is engaged in the groove 76 of the drive lever 71. In this condition, the striking portion 78 comes into contact with the crystal accommodating casing 53, and the contact lever 74 is in a position away from the 5th gear 10.

[0038] As shown in Fig. 6, when the crown is pulled out, the click lever 81 rotates counterclockwise about the shaft 82 and the positioning pin 83 is engaged in the engagement groove 92 of the click spring 91. At the same time, the contact pin 84 of the click lever 81 moves to the side of the contact surface 77 of the drive lever 71, causing the drive lever 71 to rotate clockwise about the shaft 72. Since the lever stop portion 73 of the drive lever 71 comes into contact with the stopping pin 63,

however, the lever stop portion 73 is not allowed to move. Therefore, a spring force (elasticity) inherent to the drive lever 71 causes the contact lever portion 74 and the position control lever portion 75 to be displaced, causing the contact lever portion 74 to come into contact with the 5th gear 10.

[0039] In the present invention, the contact lever portion 74 is arranged so that it has an angle (not parallel) to a tangent 90 to the outer circumference of the 5th gear which runs through the center of the shaft 72 of the drive lever. The contact lever portion 74 is also arranged to come into contact with the 5th gear 10 before the contact point at which the 5th gear 10 comes into contact with the tangent 90 in the normal rotating direction of the 5th gear 10. The striking portion 78 of the position control lever portion 75 is separated from the crystal accommodating casing 53.

[0040] When an operation to complete a hand-setting operation is carried out by pushing in the crown after the hand-setting operation has been performed by turning the crown 60, the click lever 81 rotates clockwise in conjunction with the completing operation, as shown in Fig. 7, which causes the contact pin 84 to move into the groove 76, whereby the energizing force that has been added to the drive lever 71 is released and the spring force of the drive lever 71 causes the contact lever portion 74 to recover its previous position.

[0041] In doing so, the contact lever portion 74 moves in a direction that is slightly angled from a position where it is in contact with the 5th gear 10 as shown in Fig. 7, thus a mechanical rotating force is applied to the 5th gear 10 in the direction indicated by an arrow 101 due to a frictional force developed between the 5th gear 10 and the contact lever portion 74.

[0042] When the hand-setting operation has been fully completed by pushing in the crown 60, the power generator 20 starts up, but at this moment of start up a rotating force applied to the 5th gear 10 by the drive lever 71 is transmitted to the rotor 12 via the 6th gear 11 and is added to a rotating force developed by the mainspring. As a result, a large rotating force is applied momentarily to the rotor 12. This increases the rate by which the rotor 12 rotates at the time of start up, causing a large amount of power to be outputted by the power generator in a short period of time.

[0043] At the same time, the striking portion 78 strikes against the crystal accommodating casing 53, which causes an impact to be added in the direction of vibration of the quartz crystal 52 to get it started vibrating. When the power generator 20 starts up after the crown 60 has been pushed in, a voltage is applied to the quartz crystal 52 and the quartz crystal 52 begins to oscillate. In addition to this voltage-triggered oscillation, mechanical vibration caused by the impact made by the

striking portion 78 is applied to the quartz crystal 52, thus the magnitude of vibration becomes large at the start of the oscillation, whereby a shorter time is needed to start the oscillation of the quartz crystal.

[0044] The present invention having the aforementioned features offers the following advantages.

[0045] (1) Because the rotation drive means 70 is included, which comprises the drive lever 74 that operates in conjunction with a restoring operation to restore the timepiece from a hand-setting operation performed by pushing in the crown 60, the click lever 81 and the click spring 91, and because it applies a mechanical force to the 5th gear 10, the mechanical force created by the rotation drive means 70 can be applied to the rotor 12 of the power generator via a gear train and can be added to the rotating force produced by the mainspring. Thus, a larger rotating force is applied momentarily to the rotor 12, which increases the rate by which the rotor 12 rotates at start up and makes it possible to increase the power output of the power generator 20 to a higher level in a short period of time. Therefore, the time required for the rotation control means 50 to activate after the start up of the power generator 20 is shortened, thereby reducing errors in hand-setting operations.

[0046] (2) Because the subject gear to be rotated is set to the 5th gear 10 positioned 2 gears before the rotor 12, it is possible to obtain a relatively large rotation amount for the rotor 12 compared to that of the subject gear to be rotated, and it is also possible to obtain a relatively small rotating force applied to the gear.

[0047] For example, the proportion by which the speed increases between the 5th gear 10 and the 6th gear 11 is 10 and the proportion by which the speed increases between the 6th gear 11 and the rotor 12 is 10. Thus, to rotate the rotor 12 by 90 degrees, the 6th gear 11 positioned 1 step before the rotor 12 must be rotated by 9 degrees, whereas the 5th gear 10 positioned 2 steps before the rotor 12 needs to be rotated by only 0.9 degrees. When using a frictional force such as the one created by the drive lever 74, it is not possible to rotate gears in a stable manner by more than about 5 degrees or so. Therefore, it is not possible to rotate the rotor 12 through a large rotation if the subject gear to be rotated is set to the 6th gear 11. But in the present invention the 5th gear 10 is chosen to be the subject gear to be rotated, so that a small rotation angle for the 5th gear 10 allows the rotor 12 to make a large rotation (approx. 100 times larger).

[0048] Furthermore, the proportion by which the speed increases between the 5th gear 10 and the rotor 12 is 100. Therefore, the force applied by the drive lever 71 need not be as large as it would have to be if it were applied to the 4th gear 9 or to the

3rd gear 8, which have a greater proportional increase of speed, so that the structure of the drive lever 71 can remain simple and the teeth of the 5th gear will not be worn away.

[0049] (3) The contact lever portion 74 of the drive lever 71 moves by a spring force created when the energy of the click lever 81 is released, and it is possible for the contact lever portion 74 to move at a uniform speed (force) regardless of the speed at which the crown is pushed in. Therefore, a uniform rotating force can be applied to the 5th gear 10, which makes it possible to apply a stable and uniform rotating force to the rotor 12 and this improves ease of use because the user does not need to worry about the speed at which the crown 60 is pushed in and so on.

[0050] (4) Because the rotation drive means 70 operates in conjunction with an operation to push in the crown 60 as part of a restoring operation to restore the timepiece after a hand-setting operation, the user can operate the timepiece without giving it any thought, thereby improving ease of use.

[0051] (5) The striking portion 78 of the drive lever 71 strikes against the crystal accommodating casing 53 and its impact causes the quartz crystal 52 to begin vibrating, which makes it possible to reduce the time needed for the quartz crystal 52 to enter a stable oscillation state. This makes it possible to shorten the length of time during which the rotation control means 50 cannot control time accurately, which makes it possible to reduce errors during hand-setting operations.

[0052] (6) Because the drive lever 71 operates in conjunction with a restoring operation of the crown 60 after a hand-setting operation in which the crown 60 is pushed in, the crystal accommodating casing 53 is struck, substantially simultaneously to when the power generator 20 starts up and a voltage is applied, which causes the quartz crystal 52 to start vibrating mechanically. This makes the vibration bigger when the quartz crystal 52 starts its oscillation, thereby efficiently shortening the time needed for the quartz crystal 52 to enter a stable oscillation state compared to cases where an impact is given after the oscillation of the quartz crystal 52 that has already reached a certain level.

[0053] (7) Because the position control lever portion 75 of the drive lever 71 moves by means of a spring force that is produced when the energy of the click lever 81 is released, an impact can be given to the crystal accommodating casing 53 at a uniform speed (force) regardless of the speed at which the crown 60 is pushed in. This makes it possible to maintain the mechanical force applied to the quartz crystal 52 at a uniform level, which makes it possible to maintain the time required for the quartz crystal 52 to enter a stable oscillation state at a substantially uniform level, making it

easier to correct errors. Furthermore, the speed at which the crown 60 is pushed in has no effect on the impact given to the crystal accommodating casing 53, thus the user does not need to worry about how hard to push in the crown 60, which improves ease of use.

[0054] (8) Because the striking operation performed by the drive lever 71 against the crystal accommodating casing 53 is made in conjunction with an operation to push in the crown 60 as part of a restoring operation to restore the timepiece from a hand-setting operation, the user can operate the timepiece without giving it any thought, thereby improving ease of use.

[0055] It should be understood that the present invention is not limited to the aforementioned embodiments and that the present invention includes any variations, modifications or improvements in so far as the object of the present invention can be attained.

[0056] For example, the structure of the rotation drive means 70 is not limited to the aforementioned, and the rotation drive means may be constructed in any way as long as a subject gear to be rotated can be rotated in conjunction with a restoring operation to restore the timepiece from a hand-setting operation.

[0057] Also, the subject gear to be rotated may be one of other gears than the 5th gear 10, such as the 6th gear 11, the 4th gear 9 or the 3rd gear 8. It is preferable, however, that the subject gear to be rotated be either of the 5th gear 10 or the 4th gear 9, which is positioned either 2 or 3 steps before the rotor 12, considering the amount of rotation for the rotor 12 and the force applied to the subject gear to be rotated.

[0058] Furthermore, in the aforementioned embodiment the striking portion 78 that strikes against the crystal accommodating casing 53 is formed as part of the drive lever 71 of the rotation drive means 70, but the striking portion 78 may not be necessary or a striking lever for causing an impact onto the crystal accommodating casing 53 may be built independently of the drive lever 71.

[0059] A restoring operation to restore the timepiece from a hand-setting operation is not limited to an operation that uses a crown 60. If a button is provided separately specifically for hand-setting operations, for example, it may be arranged so that the rotation drive means 70 operates in conjunction with an operation to push the button. In this case, the drive lever 71 would operate in conjunction with the operation to push the button, which would allow an impact to be given simultaneously to the crystal accommodating casing 53.

[0060] Concerning the timing of the impact applied to the crystal accommodating

casing 53 by means of the drive lever 74, the impact need not necessarily be applied simultaneously with the application of a voltage to the quartz crystal 52, and an impact may be applied at any time before the quartz crystal 52 enters a stable oscillation state.

Effectiveness of the present invention

[0061] As discussed above, the present invention increases the rate at which the rotor rotates when the power generator starts up compared to the prior art, which reduces the time required for the rotation control means to start up after the power generator starts up, thereby reducing errors during hand-setting operations.

Brief Description of the Drawings

Fig. 1 is a top view showing the principal mechanism of an electronically controlled mechanical timepiece according to an embodiment of the present invention.

Fig. 2 is a cross-sectional view showing the principal mechanism shown in Fig. 1.

Fig. 3 is another cross-sectional view showing the principal mechanism shown in Fig. 1.

Fig. 4 is diagram showing a control circuit of the aforementioned embodiment.

Fig. 5 is a schematic diagram showing a rotation drive means of the aforementioned embodiment.

Fig. 6 is a schematic diagram showing operation of the rotation drive means of the aforementioned embodiment.

Fig. 7 is another schematic diagram showing operation of the rotation drive means of the aforementioned embodiment.

Fig. 8 is a schematic diagram showing a holder structure for a quartz crystal of the aforementioned embodiment.

Reference numbers

1	Barrel gear
1a	Mainspring
2	Main plate
3	Gear train bridge
12	Rotor
13	Minute hand
14	Second hand

15	Stator
16	Coil block
20	Power generator
50	Rotation control means
51	IC
52	Quartz crystal
53	Crystal accommodating casing
60	Crown
70	Rotation drive means
71	Drive lever
73	Lever stop portion
74	Contact lever
75	Position control lever
81	Click lever
91	Click spring